High-Efficiency Post Combustion Carbon Capture System

PCI Precision Combustion, Inc.

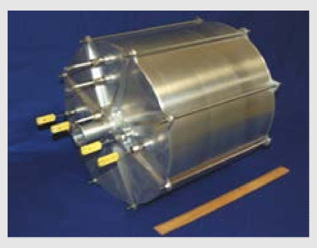
Codruta Loebick, Benjamin Baird, Jeff Weissman, Anthony Anderson
DOE Project DE-SC0017221 SBIR Phase II (05/2018-05/2020)
DOE Program Manager: Andrew O'Palko

Project Goals

- Novel manufacturing process enables use of advanced materials to enhance carbon capture performance and reduce cost.
- Enable modular and advanced manufacturing to realize improvements to process components which optimize gas transfer rates at the low costs in carbon capture systems.

Precision Combustion, Inc.

Precision Combustion, Inc. (PCI) is a clean energy technology company developing and manufacturing advanced sorption and catalytic devices and systems for energy sector applications.



Regenerable Sorption Reactors:

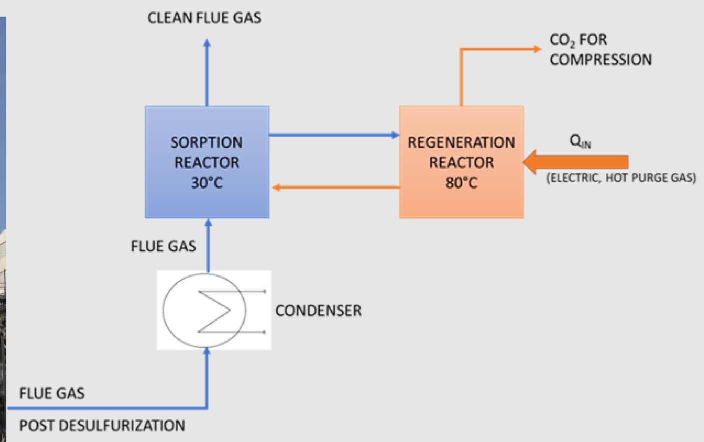
- CO_2 capture from flue gas;
- CO_2 and VOC removal from indoor air;
- Chemical & biological filters for chemical warfare agents & toxic chemicals;
- Air revitalization for long-duration manned spaceflight.

PCI's Approach to Carbon Capture Solutions

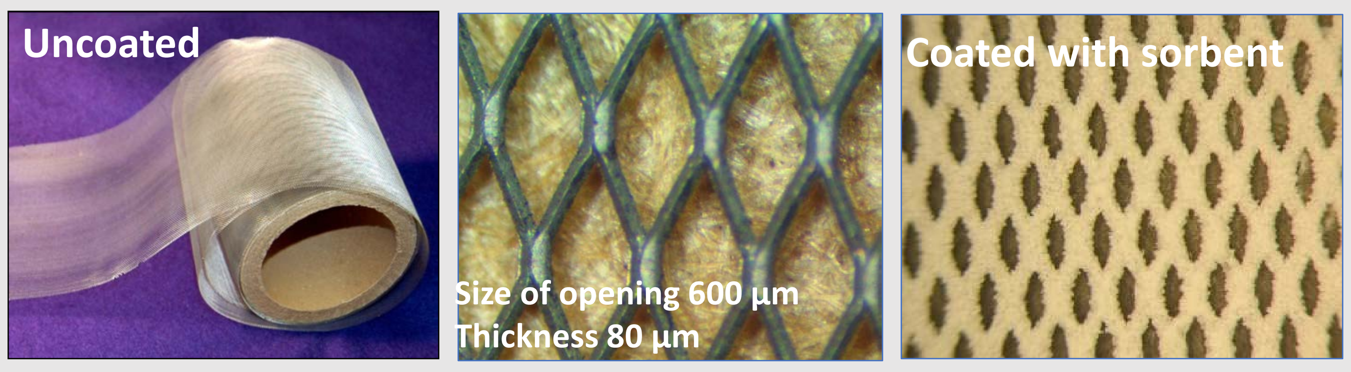
Compact, modular Post Combustion Carbon Capture System (PCCCS) utilizing high internal volume sorbents, for carbon capture, supported on a tailorable mesh substrate (Microlith®).

Our system enables:

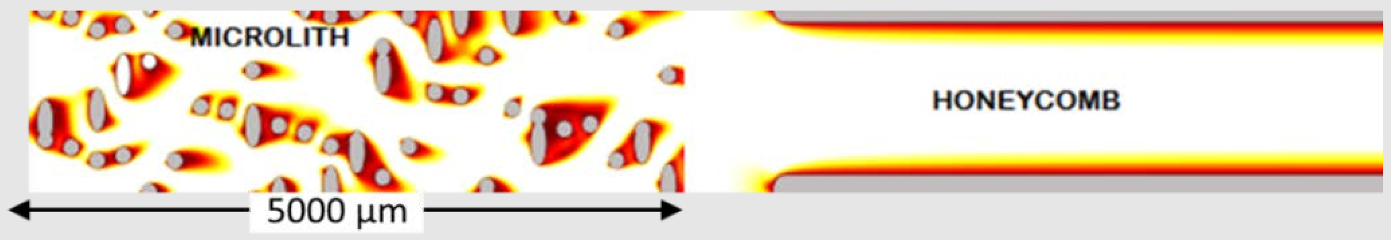
- Low pressure drop;
- High volumetric utilization;
- High mass transfer;
- Lower energy of regeneration.



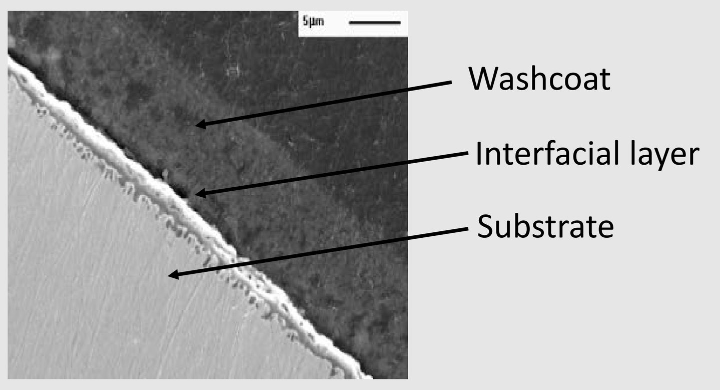
Microlith® Substrates



- 5-10x process intensification with corresponding reduction in PCCCS volume.
- Greatly reduces boundary layer formation, with reduced pressure drop for similarly performing PCCCS .
- Increased mass and heat transfer coefficients and enhanced diffusion of gas in the sorbent.
- Immobilizing the sorbent increases its lifetime by reducing attrition.



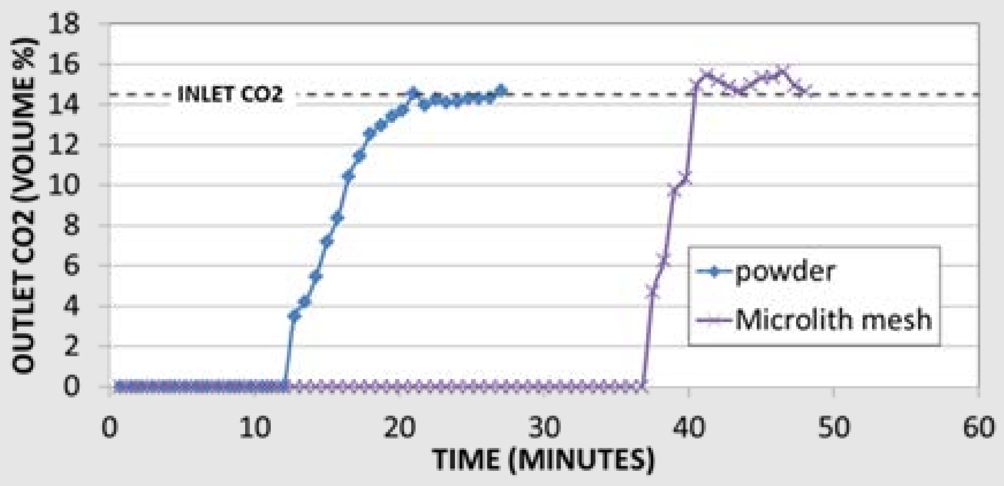
CFD analysis of fluid flow behavior in 2D cross-sections through a stack of 21 Microlith mesh elements (left), a single channel in a honeycomb monolith (right). Microlith mesh disrupts boundary layer formation.



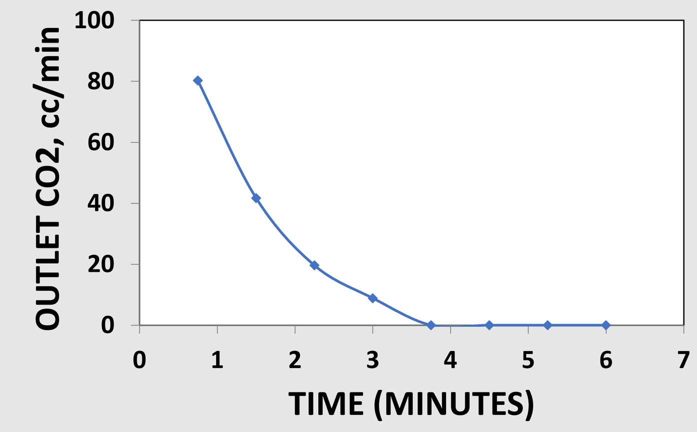
SEM micrograph of Microlith mesh strand coated with sorbent.

- Proprietary coating process for sorbent application on Microlith substrate;
- High sorbent loading with good adhesion and uniform coating;
- Durability over hundreds of hours of operation & multiple thermal cycles;
- Continuous sorbent & catalyst coating line for large volume production.

Microlith® Substrate Performance

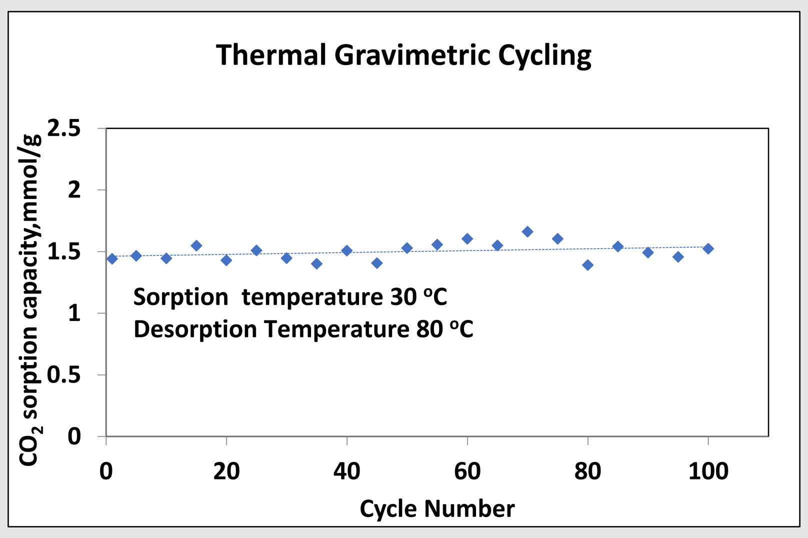


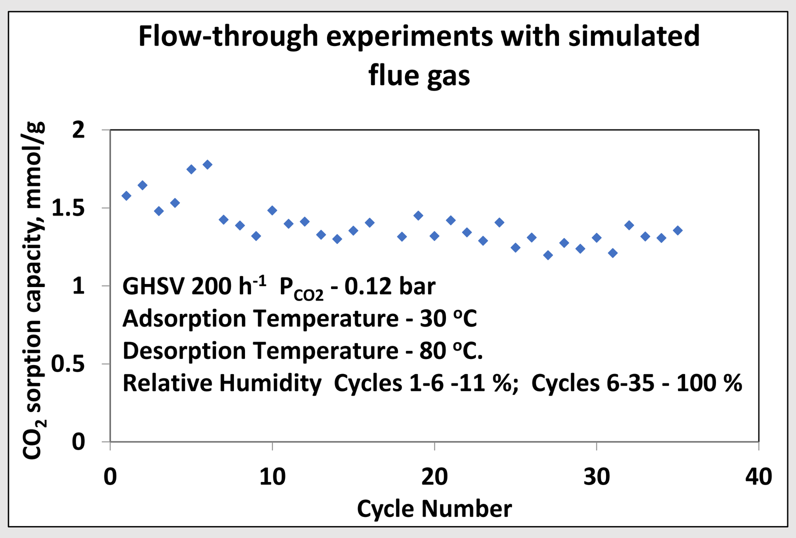
CO_2 breakthrough curves for powder bed and sorbent coated Microlith mesh, measured at identical space velocity, based on sorbent volume, demonstrating **increased bed utilization** from the Microlith substrate.



Fast thermal response of Microlith Substrate ideal for **rapid thermal cycling** with minimal energy penalty.

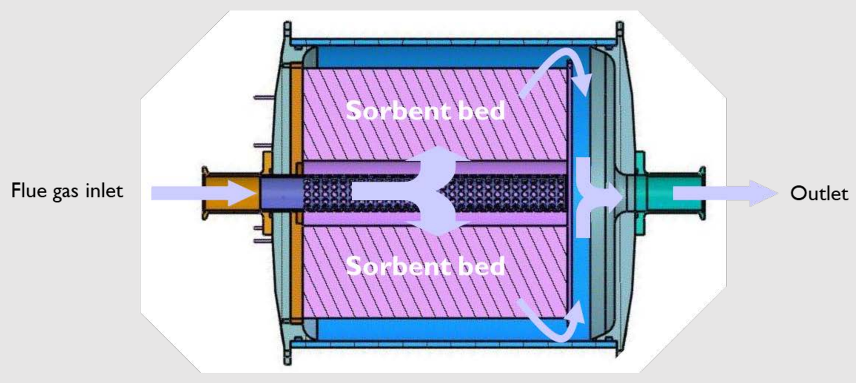
Sorbent Performance

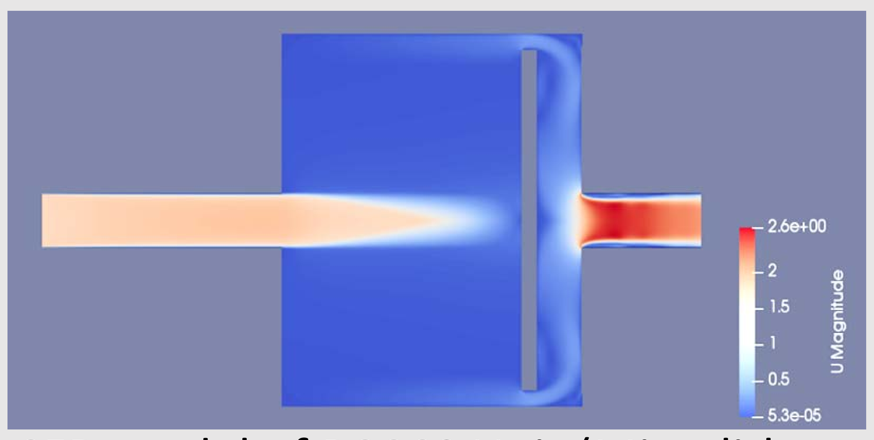




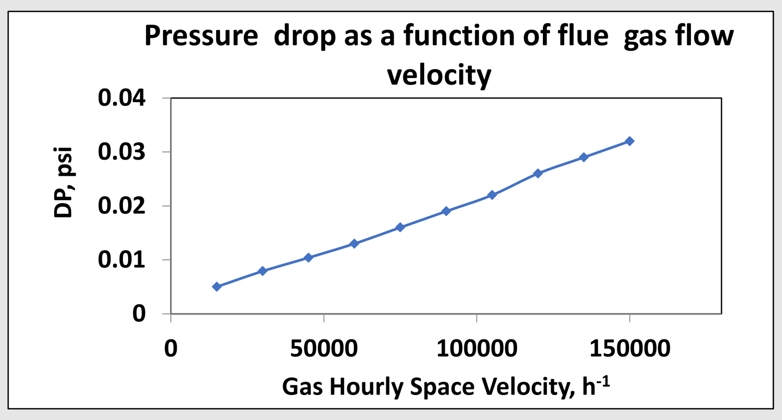
PCCCS Unit Design

- Sorbent bed consists of coiled layers of Microlith meshes coated with sorbents;
- Ability to coat different sections of mesh with different sorbents for one step removal of CO_2 and other contaminants.





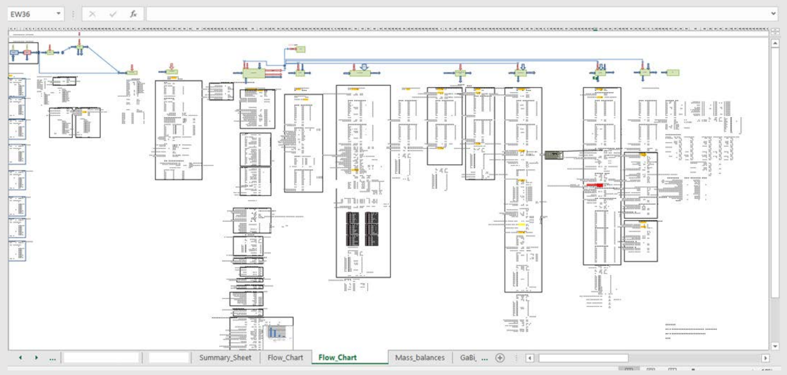
CFD model of PCCCS Unit (Microlith media), GHSV – 160,000 h^{-1}



PCCCS unit performance to be validated with coal-derived flue gas at the National Carbon Capture Center in Wilsonville, Alabama.

Plant Energy Penalty for PCCCS Operation

NETL Plant Flexible Model – adapted to Microlith PCCCS Unit



Preliminary Increase in COE data

Plant Type	Base Plant	MEA Plant	Microlith Plant
CO2 Emissions (kg/MWHnet)	789	109	105
CO2 captured (kg/MWHnet)	0	981	945
CO2 Capture Efficiency (%)	0	90	90
Net Plant HHV Efficiency (%)	39.4	28.6	29.7
Existing Coal Producer Cost of Electricity ($/MWh)	39.95	65.24	54.35
Increase in Cost of Electricity (%)	0	63.3	36.0

Model to be integrated with DOE Carbon Capture Initiative Software

Aligns with DOE's goals of:

- Step-change reductions in both cost and energy penalty of carbon capture;
- Reducing the impact of CO_2 capture on power generating capacity;
- Improving the cost effectiveness of novel technologies for CO_2 capture so that fossil based systems with carbon capture are cost competitive.

Precision Combustion, Inc., 410 Sackett Point Rd, North Haven, Connecticut 06473
www.precision-combustion.com

For more information contact:
Anthony Anderson
203.287.3700 x290
aanderson@precisiom-combustion.com

Technical contact:
Codruta Loebick
203.287.3700 x284
cloebick@precisiom-combustion.com